

Volcanoes, Plates, and Chains

Focus

Formation of seamounts in the Gulf of Alaska

Grade Level

5-6

Focus Question

How were seamounts in the Axial-Cobb-Eikelberg-Patton chain formed?

Learning Objectives

Students will be able to describe the processes that form seamounts.

Students will be able to describe the movement of tectonic plates in the Gulf of Alaska region, and explain the types of volcanic activity that might be associated with these movements.

Students will be able to describe how a combination of hotspot activity and tectonic plate movement could produce the arrangement of seamounts observed in the Axial-Cobb-Eikelberg-Patton chain.

Materials

- ☐ Framed screen with outline map of the Gulf of Alaska (see instruction sheet)
- ☐ Small can of Great Stuff (from hardware store)
- ☐ Overhead transparency Gulf of Alaska Seamounts
- ☐ (Optional) Overhead transparency of Patton seamount 3-D bathymetric model which can be downloaded from <http://ridge.coas.oregonstate.edu/rkeller/seamounts.html>

Audio/Visual Materials

- ☐ Overhead projector
- ☐ (Optional) Computer video of simulated fly-around of the Patton Seamount; download from http://ridge.coas.oregonstate.edu/rkeller/Fly_around.mov

Teaching Time

20 - 30 minutes

Seating Arrangement

Classroom style or in cooperative groups around tables

Maximum Number of Students

As many as are in the class

Key Words

Basalt
Rift
Subduction
Hotspot
Seamount
Magma

Background Information

Seamounts (also called guyots) are undersea mountains that rise from the ocean floor, often with heights of 3,000 m (10,000 ft) or more. Compared to the surrounding ocean waters, seamounts have high biological productivity, and provide habitats for a variety of plant, animal, and microbial species. Numerous seamounts have been discovered in the Gulf of Alaska. Many of these seamounts occur in long chains that parallel the west coast of the U.S. and Canada. One of the longest chains, known

as the Axial-Cobb-Eikelberg-Patton chain, is being intensively studied by the Ocean Exploration 2002 Gulf of Alaska Expedition. What formed these underwater mountains in the first place, and why are they arranged in chains? These are two of the questions that the Gulf of Alaska Expedition hopes to answer.

Seamounts are generally thought to be the remains of underwater volcanoes that can be formed in several ways. Many volcanoes are associated with the movement of the tectonic plates that make up the Earth's crust. Where these plates move apart (for example, along the mid-ocean ridge in the middle of the Atlantic Ocean) a rift is formed, which allows magma (molten rock) to escape from deep within the Earth and harden into solid rock known as basalt. Where tectonic plates come together, one plate may descend beneath the other in a process called subduction, which generates high temperatures and pressures that can lead to explosive volcanic eruptions (such as the Mount St. Helens eruption which resulted from subduction of the Juan de Fuca tectonic plate beneath the North American tectonic plate). Volcanoes can also be formed at hotspots, which are thought to be natural pipelines to reservoirs of magma in the upper portion of the Earth's mantle.

What produced the seamounts in the Axial-Cobb-Eikelberg-Patton chain? One hypothesis is that they were formed over the Cobb hotspot which is currently located off the coast of Oregon near the ridge between the Juan de Fuca and Pacific tectonic plates. As the Pacific plate moved away from the Juan de Fuca plate, different portions of the Pacific plate

were exposed to the Cobb hotspot, causing volcanoes produced by the hotspot to be aligned in the same direction that the plate was moving.

LEARNING PROCEDURE

1. Explain that seamounts are the remains of underwater volcanoes, and that they are islands of productivity compared to the surrounding ocean environment. You may want to use a color transparency of the 3-D bathymetric model of the Patton seamount, and/or the video of the simulated fly-around during this discussion. Describe the general process of underwater volcano formation, and introduce the concept of hotspots. You may need to review the concept of plate tectonics, if students are unfamiliar with this idea and the relevant terms. Be sure to distinguish the type of volcanic activity at spreading ridges (typically a slow ooze of lava) from volcanoes near areas of subduction (often explosive eruptions such as Mt. St. Helens).
2. Demonstrate how periodic volcanic eruptions at a hotspot and movement of a tectonic plate could produce a chain of seamounts similar to that found in the Gulf of Alaska: Have one or two students hold the framed screen above the can of Great Stuff (which the teacher should control!). Position the can so that the starting point is near the 41 Ma mark. Have them very slowly move the screen in the direction shown by the Plate Movement arrow. As the screen moves, gently release a small squirt of Great Stuff to produce a

small mound on top of the screen (you should practice this in advance to get a feel for the trigger!). Make a mound at the 41 Ma, 38 Ma, 9 Ma, and 0 Ma marks. Use the Gulf of Alaska Seamounts overhead transparency to explain that the framed screen represents the Pacific plate, the four mounds of Great Stuff represent the Patton, Murray, Warwick, and Axial Seamounts, and the can of Great Stuff represents the Cobb hotspot. Tell the students that Ma stands for millions of years, and discuss the significance of 0 Ma at the Axial Seamount (an age of 0 means that the seamount is still being formed).

THE BRIDGE CONNECTION

www.vims.edu/bridge/geology.html

THE "ME" CONNECTION

Have students write a first-hand account of an exploratory dive to investigate formation of the Axial Seamount. You may want to have them do library or internet research to back up their report.

CONNECTIONS TO OTHER SUBJECTS

English/Language Arts, Geography, Mathematics

EVALUATION

Have students write a newspaper style report about events happening on the Juan de Fuca ridge. Tell them it is OK to include events that are happening slowly (such as tectonic plate movement) as well as events happening more quickly (such as volcanic eruptions). Their reports should include subduction beneath the North American plate (and possibly associated

volcanic activity), seafloor spreading, and events associated with the Cobb hotspot (such as formation of the Axial Seamount).

EXTENSIONS

Have students visit <http://oceanexplorer.noaa.gov> to keep up to date with the latest Gulf of Alaska Expedition discoveries.

RESOURCES

<http://oceanexplorer.noaa.gov> - Follow the Gulf of Alaska Expedition daily as documentaries and discoveries are posted each day for your classroom use. A wealth of information can also be found at both of these sites.

<http://ridge.coas.oregonstate.edu/rkeller/seamounts.html> - Background on seamount exploration and research in the Gulf of Alaska

<http://volcano.und.nodak.edu/vwdocs/vwlessons.atg.html> - Teacher's guide on plate tectonics, hot spots, and volcanoes

<http://newton.physics.wvu.edu:8082/jstewart/scied/earth.html> - Earth science education resources

<http://www.sciencegems.com/earth2.html> - Science education resources

[http://earth.leeds.ac.uk/dynamic earth](http://earth.leeds.ac.uk/dynamic%20earth) - Background on plate tectonics

<http://www.sci.lib.uci.edu/HSG/Ref.html> - References on just about everything



NATIONAL SCIENCE EDUCATION STANDARDS

Content Standard A: Science as Inquiry

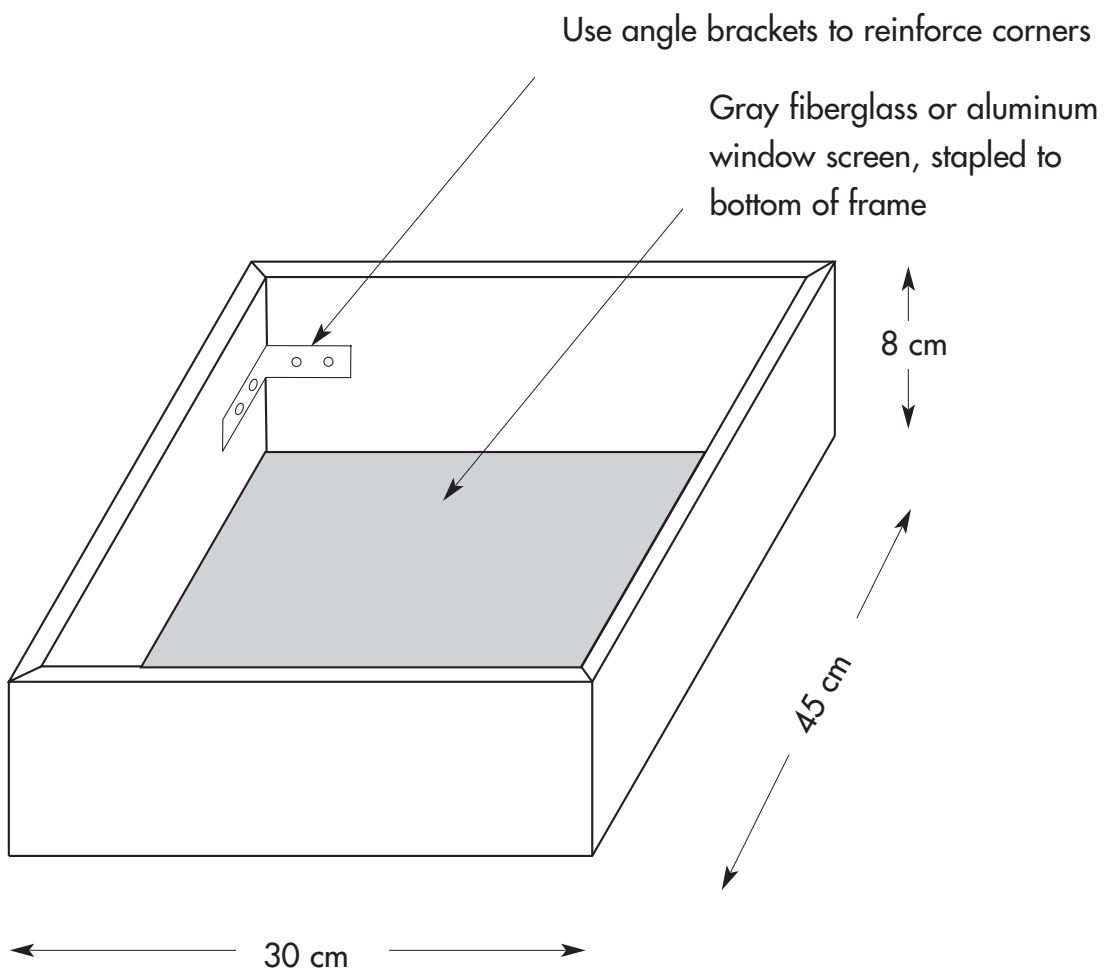
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Content Standard D: Earth and Space Science

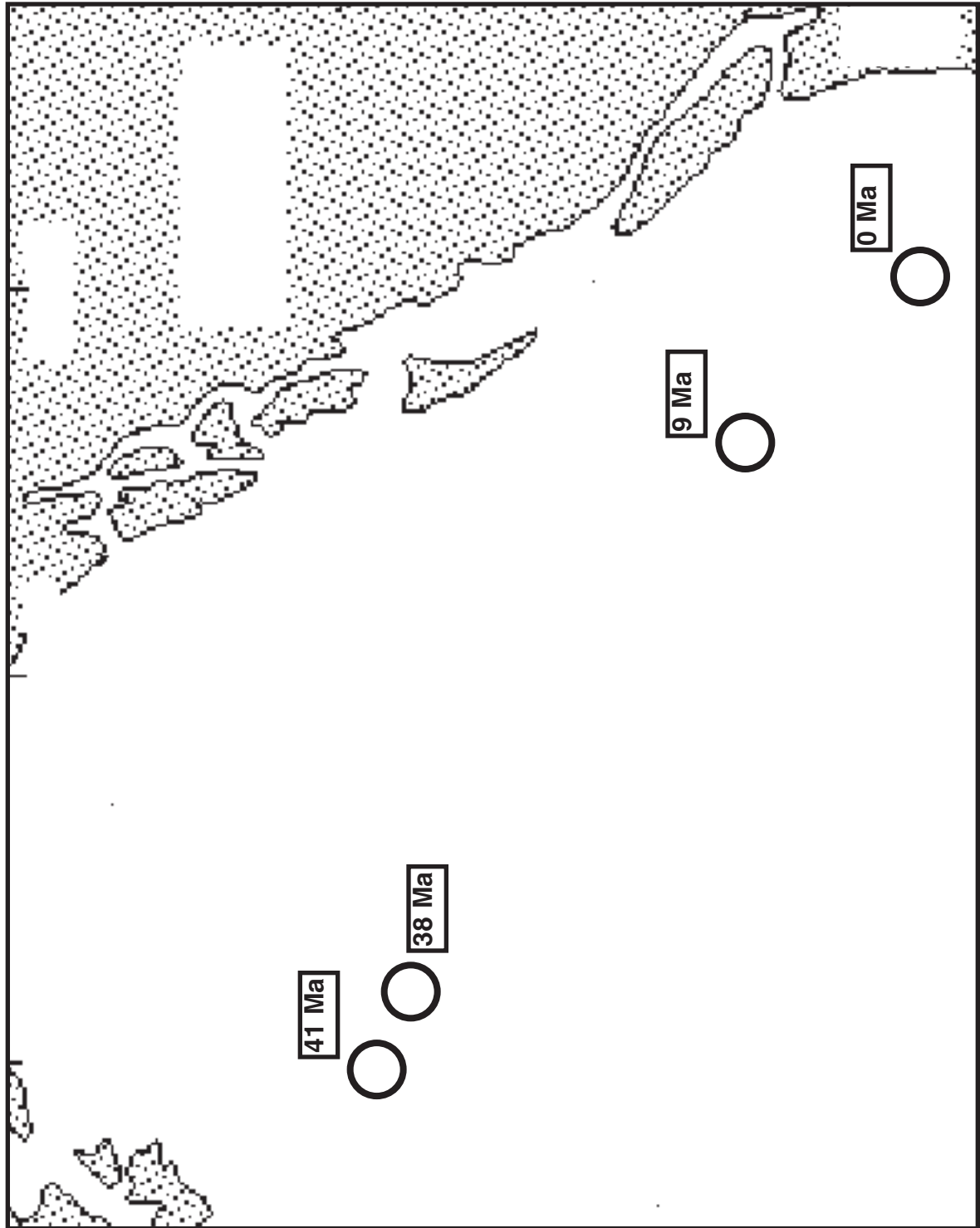
- Structure of the Earth system

Framed Screen Instruction Sheet

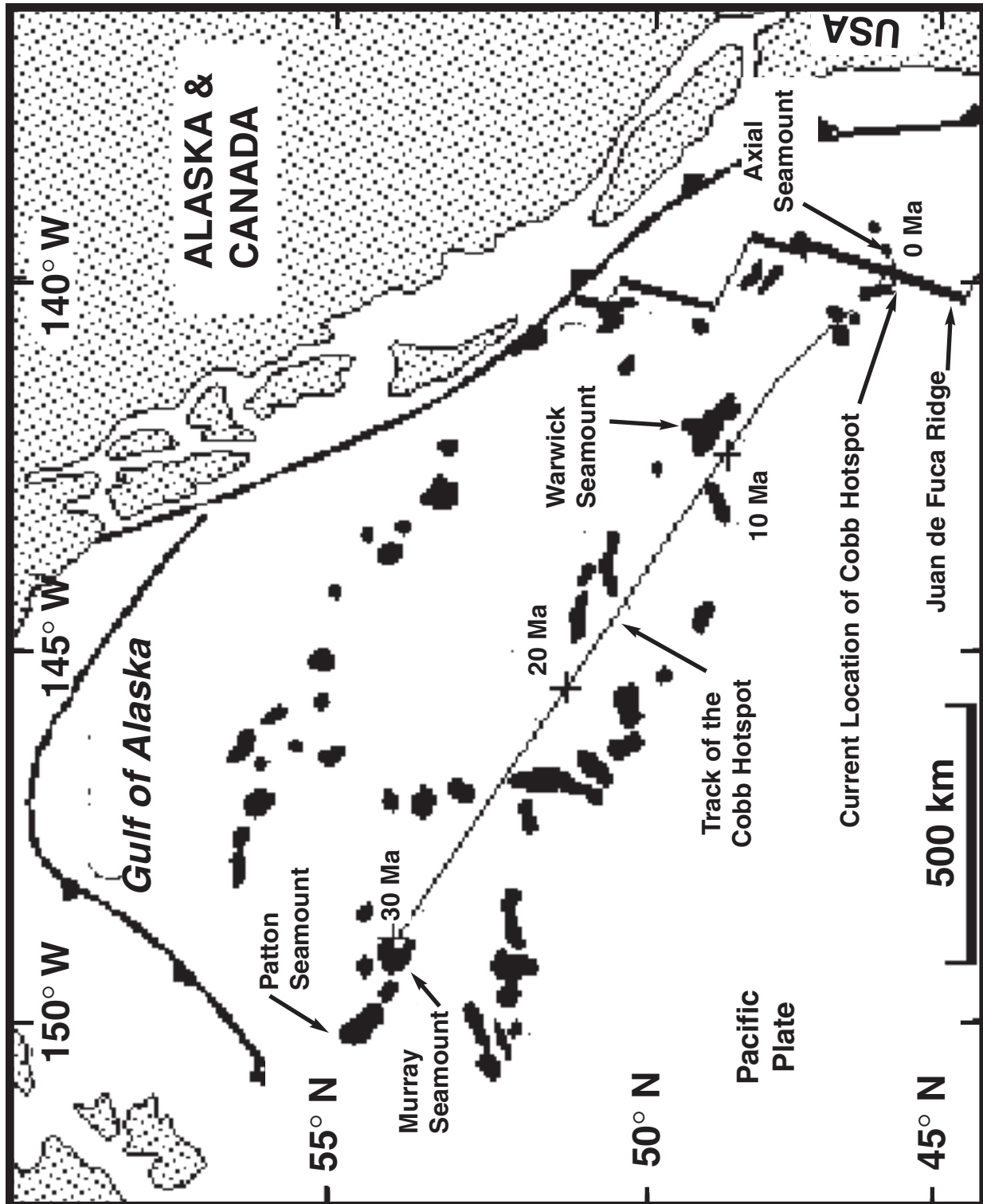
Make frame from 3/4" thick plywood or 1" x 3" pine lumber. Fasten corners with glue and screws, reinforce with angle brackets in corners. Staple window screen to bottom of frame. Enlarge the outline map of the Gulf of Alaska to 11" x 17" on a photocopier, then trace the map onto screen with black marking pen.



Map for use with framed screen and Great Stuff
(enlarge it to fit on an 11 x 17 sheet)



Gulf of Alaska Seamounts Map
(for overhead)



<http://ridge.coas.oregonstate.edu/rkeller/seamounts.html>

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